The Spitzer Space Telescope Research Program for Teachers and Students: The Wiki

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Abstract: The Spitzer Science Center (SSC) and the National Optical Astronomy Observatory (NOAO) have designed a program for teacher and student research using observing time on the Spitzer Space Telescope. (For more information on this program, please see our companion poster, Rebull et al.) As part of this program, we are developing a wiki, where the scientists, teachers, and students can share the materials they have developed and interact with each other. The wiki currently has background information, some general lessons and discussion pages; it also provides a place for the teams to continue working on their specific research projects. This poster will describe some of the wiki contents, and our plans for future development.

The Wiki as an informational and Tutorial Tool

Presenting the Research Process to High School Students

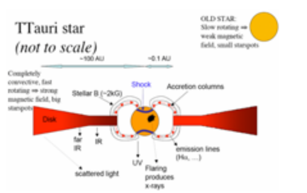
Young Stars in IC 2118

We are studying a nebula (cloud of gas and dust) called Interstellar Cloud 2118, or the Witch Head Nebula, that is being excited by a young, very hot star called Rigel. Because Rigel is so energetic, it sends off shock waves that hit the nebula, compressing some of the gas (at least, this is what astronomers think is happening). The gas starts to clump as it's compressed, which creates a gravitational field, which attracts more matter, which creates more gravity, which attracts more mass, and so on, until it eventually accumulates the critical mass needed to form a star. We think this particular nebula is forming lots of newborn stars; in fact, we call it a cocoon, a nursery, or a natal cloud.

However, we have to actually identify the stars we think it contains, and therein lies the problem. How do you know a newborn star when you see one? Does it look different from a middle-aged star? How can you tell if it's in your cloud, and not a star in front of it? How can you tell that it's not a distant galaxy? It's important to remember that you can't perceive depth in space; everything is so far away that every object looks like a point source, a tiny dot of light. And it could be a certain magnitude (brightness) because it is really far away but very bright, or not so bright but very close. A real dilemma!

So this is what research scientists (and research students and teachers!) do. We have all these questions, and start figuring out ways to answer them. In the case of astronomy, the only phenomenon we have to observe and measure is the light that comes from the object. The distances are so far that we can't travel to see the objects or bring back samples, so we use the only thing they can send us: their light. And if light weren't the fastest thing going we might not even have that. But it is, and we do, and astronomers have gotten very good at observing, measuring, and analyzing light from great distances.

The Case of the "Missing" T-Tauris: Identifying Young Star Candidates in IC2118



Rebull (2007) after Hartman (1998)

Characteristics of Young Stars: how do you tell which of these point sources of light is a young star?

Young stars have unique characteristics. Like their young, human counterparts, they are lively, hyperactive, and change quickly as youngsters. The graphic above details most of these. We look for

- **Infrared excess** coming from the cooler, circumstellar disc that was originally its cocoon; as the star gets older this thins out and is harder to detect. Spitzer is perfect for this!
- **Variability of light** produced by
  - **UV emission** created by shocks of matter falling onto the star's surface from its accretion disc
  - **Starspots** covering huge areas of the star's surface, which cause brightening and darkening over hours and days
  - **Outflows of ejected gas** from the poles of the rotating star; this releases angular momentum, allowing accretion material to fall towards the star
- **Flaring X-rays** caused by convection due to the fast rotation of young stars
- **Emission lines** from emitted/absorbed accreting matter; may be red-shifted as it falls onto star
- **Fast rotation rate**; need to get projected rotational velocity
- **Spatial location**; young stars tend to form together out of the same area of a cloud
- **Similar brightnesses** found by placing candidates on a color-magnitude diagram
- **Spatial motion** showing proper motion as the cluster moves together through space

The Search for Young Star Candidates

Imagine yourself a district attorney in a star federation trying to make the case that these point sources in IC2118 are T-Tauri stars. You must convince the jury (your astronomer colleagues) that these are, indeed, small young stars tucked away in their IC2118 nursery.

Like any good prosecutor, you need a **preponderance of the evidence**.

How many of the characteristics listed above for young stars can you "pin" on a candidate?

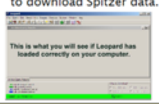
Is it enough to "convict"?

Some characteristics can only be seen by chance—you have to catch the star in the act, so to speak.

Your surveillance begins: observing the stars in as many wavelengths and epochs as you can, and analyzing the evidence.

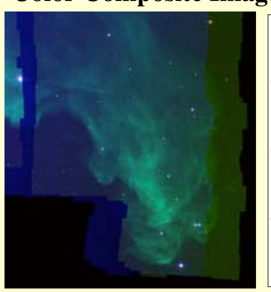
Research Tools

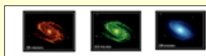
- This section is designed to meet the needs of researchers in all stages of their project. It serves as a comprehensive tutorial covering a range of topics from basics, such as the nature of Spitzer mosaics, to advanced topics, such as finding already reduced Spitzer data.
- An important component of research is obtaining and analyzing data. The research tools section teaches the user how to download Spitzer data using Leopard, the software most astronomers use to download Spitzer data.



The image at the left shows the user interface window for Leopard. The program runs on Windows, Mac, and other platforms and is available free of charge at http://ssc.spitzer.caltech.edu/propkit/spot.

Color Composite Images





- This section includes a brief introduction explaining the benefits of creating a color composite image.
- It also provides instructions for creating such an image using several different image processing programs.
- Color composite images using Spitzer and other data are useful for studying the various features of an object.

The image of M81, below, was created by combining the three images shown on the left, taken at 24, 8 and 3.6 microns, respectively.

- Also included in the advanced topics section are in-depth discussions of color-color diagrams, spectral energy distributions and background information on studying young stars; particularly helpful is the section on the characteristics of young stellar objects.

Student Research Communication Tool

Students Teaching Other Students

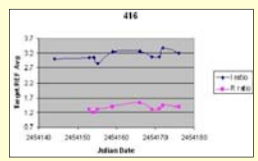
-- Danielle 07:21, 19 December 2007 (PST) I think that Rachele S. is a wonderful example as to what the wiki is all about. I sat with her last night and threw all kinds of information at her about the project [IC2118 YSO Research] and everything it includes including the T-tauri monitoring. I used two pages off of the wiki to help teach her. I used the "Finding Cluster Members" page as well as "Making Light Curves for our YSO Candidates" page.

-Dani 10:53, 4 December 2007 (PST) ***UPDATE IN HOW TO POST PLEASE READ*** - When posting, rather than typing your name and time, simply click the icon above the Subject/Headling square that looks like a squiggle. It is the second icon from the right. Click that before you start your post, it will post your name date and time for you. and then at the end of the post, simply type [end]

--Amccool 12:00, 4 December 2007 (PST)Hey this is my first time posting am I doing it right? Um as far as progress I am working on renaming the images that did not get burned to my disc correctly, I am also trying to finish my outline of chapter 14 and then beginning chapter 15 to complete my hours. If this post looks ok please let me know. [END]

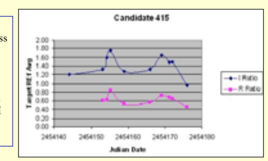
Students Sharing Research Results

Students involved in the IC2118 Research project are monitoring YSO candidates that have been identified using the Spitzer Space Telescope. The T-Tauri Candidate intensity value is compared to the average intensity value of the non-T-Tauri Candidates in the field, and using Microsoft Excel students plot light curves with this data. The plots can then be shared with other students via the Wiki.



--NicholasJamesKelley 10:17, 11 December 2007 (PST)This area will be used to show the current progress I am making toward proving that Candidates 415 and 416 are T-Tauri Stars.

--NicholasJamesKelley 10:47, 7 December 2007 (PST) These are my light curves for the 2 candidates that I am monitoring for Spitzer and the Pittsburgh Science fair. I am currently monitoring to get more accurate curves to take with me.



Students Sharing NEW Data Analysis Techniques

Two things we believe to be true about YSO's or T-Tauri candidates is that they should have an excess of dust around the star, and the star itself should be active. The excess of dust around the object would be indicated by a higher than normal emission in the infrared, and highly active stars give off an strong H-alpha emission. Unfortunately high schools rarely have access to the sort of high end equipment necessary for spectral analysis of stars, however more and more lower end internet accessible telescopes are coming online. We believe we have identified a technique that can be used with relative ease to identify stars with both infrared excess and H-alpha emissions.

Identification of Infrared Excess – Image YSO targets in both R and I. Using MaxIm DL or some other image analysis software with photometric capabilities measure intensity of all objects in the image. Determine the I/R intensity ratio for each object. On a color color plot (see below), objects with significant dust should break away from those stars with normal black body curves.

Identification of H-alpha Emission – Image YSO targets using both a broadband R filter and a narrow band H-alpha filter. Since the H-alpha filter is a narrow part of the broadband R filter (see figure below), a H-alpha/R intensity ratio can be used to determine stars with an H-alpha emission line. objects with significant H-alpha emissions should break away from those stars with normal emissions.